shaft **254** at a distance Db from the central shaft axis **258** Db which greater than Da (Db>Da). Thus, the vibration source **12** is coupled to the shaft **254** at a point closer to the central shaft axis **258** than the transducer **18**.

[0089] In operation, the energy harvester **10** having the asymmetrical lever amplifier **250** as the amplifier **20** receives a motion from the vibration source **12** which moves the transducer **18**. Specifically, as indicated by the arrows shown in FIG. **12**, the motion from the vibration source **12** exerts a movement upon the input link **256**. In response to the motion, the shaft **254** pivots about the central shaft axis **258**, thereby moving the output link **257**. Accordingly, the link **256**B is displaced and moves the first part **22** of the transducer **18** along the central axis **26** which is parallel with the y-axis. In FIG. **12**, the frame **252** is omitted to clearly show the shaft **254**.

[0090] Similar to the symmetrical level amplifier **200**, the asymmetrical lever amplifier **250** has a gain substantially equal to the distance between the output link **257** and the central shaft axis **258** over the distance between the input link **256** and the central shaft axis **258** (G≈Db/Da). Accordingly, the distance travelled by the input link **256** in response to the motion from the vibration source **12** is less than the distance travelled by the transducer **18** in response to the output link **257**.

[0091] The symmetrical level amplifier **200** and the asymmetrical lever amplifier **250** have relatively simple and compact structure with the least number of components in comparison to the concentric gear amplifier **100** and the gear-crank amplifier **150**, thereby further minimizing frictional and mechanical loss. However, the amplifier **200** and **250** accommodate a limited amount of displacement, whereas the concentric gear amplifier **100** and the gear-crank amplifier **150** are capable to operate under substantially unlimited amount of input displacement. To achieve the maximum amplification, it is preferred to have the lever or the asymmetric shaft perpendicular to the vibration axis (e.g. the y-axis).

[0092] The amplifier **20** may be a linkage based amplifier. A linkage amplifier includes a plurality of links which are configured to move in a predefined movement. The linkage amplifier receives a motion from the vibration source **12** and transfers an amplified motion via the predefined movement to the transducer **18**. The gain of the linkage amplifier is based on many factors, such as the number of links, the length of the links, and the predefined movement.

[0093] FIGS. **13-15** depict an example embodiment of a scissor linkage amplifier **300** which can be used as the amplifier **20** in the energy harvester **10**. The scissor linkage amplifier **300** includes a frame **302**, and a plurality of links **304** (**304**A-**304**F) connected at multiple joints **306**. The frame **302** is attached to the housing **16**. The links **304** and the joints **306** are configured such that the scissor linkage amplifier **300** has link lengths of L**1** and L**2**, where the length is measured between two joints **304** and L**1**<L**2**.

[0094] The joints **306** include a fixed joint **306**A, transferring joints **306**B, an input joint **306**C, and an output joint **306**D. The fixed joint **306**A is coupled to the frame **302**. The links **304**A-**304**F pivot about the joints **306** or, in other words, about the z-axis. As the input member **32**, the input joint **306**C is coupled to the vibration source **12**. As the output member **34**, the output joint **306**D is coupled to the transducer **18**. In the example, embodiment, the input joint **306**C and the output joint **306**D are depicted as having a rod or a peg which can be used to couple to vibration source **12** and the transducer **18**, respectively. It is understood that other attachments means may be used to couple the scissor linkage amplifier **300** to the vibration source **12** and the transducer **18**.

[0095] As the transmission member **36**, the links **304** move in a scissor like movement about the y-axis in response to the motion received at the input joint **306**C from the vibration source **12**. The input joint **306**C and the output joint **306**D are positioned along the y-axis, and the transferring joints **306**B are symmetrically positioned on either side of the y-axis (FIG. **14**). As the links **304**C, **304**D move, the joints **306**B move toward or away from the y-axis. When the joints **306**B move away from the y-axis, a length of the scissor linkage amplifier **300** measured along the y-axis decreases, and as the joints **306**B move toward the y-axis, the length of the scissor linkage amplifier **300** increases.

[0096] The input joint **306**C couples the links **304**C, **304**D. Specifically, links **304**C, **304**D are each separated into two sub-links having the length L**1** and L**2**. The L**2** portion of the links **304**C, **304**D are coupled to links **304**F, **304**E which have a length of L**2**. The links **304**F, **304**E are coupled at the output joint **306**D.

[0097] In operation, the energy harvester **10** having the scissor linkage amplifier **300** as the amplifier **20** receives a motion from the vibration source **12** which moves the transducer **18**. Specifically, the motion from the vibration source **12** is applied to the links **304**C, **304**D via the input joint **306**C. In response to the motion, the links **304** pivot about respective joints **306**, such that the input joint **306**C and the output joint **306**D move along the y-axis (FIGS. **14** and **15**). Accordingly, the output joint **306**D moves the first part **22** of the transducer **18** along the central axis **26** which is parallel with the y-axis. Due to the arrangement of the links **304** and the length of the links coupling the input joint **306**C and the output joint **306**D, the input joint **306**C moves a distance D**1**, while the output joint **306**D moves a distance D**2** which is greater than D**2** (FIG. **14**).

[0098] The scissor linkage amplifier **300** has a gain G that can be calculated by Equation 3, shown below, where $n_{1\text{-}output}$ and $n_{2\text{-}output}$ are the numbers of links with length of L**1** and L**2**, respectively, between the fixed joint **306**A and the output joint **306**D, and $n_{1\text{-}input}$ and $n_{2\text{-}input}$ are the numbers of links with length of L**1** and L**2**, respectively between the fixed joint **306**A and the input joint **306**C.

$$\text{Equation 3: } G = \frac{(n_{1-output} \times L1 + n_{2-output} \times L2)}{(n_{1-input} \times L1 + n_{2-input} \times L2)}$$

[0099] FIGS. **16-18** depict an example embodiment of a scissor-slider linkage amplifier **350** which can be used as the amplifier **20** in the energy harvester **10**. The scissor-slider linkage amplifier **350** includes a slider **352**, a plurality of links **354** (**354**A-**354**D), and a plurality of joints **356** (**356**A-**356**G). The slider **352** defines a path along which the links **354** and the joints **356** extend and retract. The slider **352** is coupled to the housing **16**, and has its longitudinal axis parallel with the y-axis.

[0100] The links **354** are coupled to the slider **352** via rods **358** (**358**A-**358**D). The rods **358** include a fixed rod **358**A, an input rod **358**B, an alignment rod **358**C, and an output rod **358**D. The fixed rod **358**A is stationary and does not slide